Indoor target tracking using improved RSSI In WSN

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Abstract : Localization of wireless nodes is one of the basic aspects of wireless sensor networks. For Indoor localization the RSSI (Received signal strength indicator) based target tracking is mostly used because it is very economical, no any additional hardware required, and it is very easy to understand. But the problem with pure RSSI scheme is the RSSI value get fluctuated by the environmental conditions and also due any other physical disturbances. So to improve the accuracy of system we use the kalman filter and unscented kalman filter. This paper presents the results of all these filters implementation for target tracking.

***IndexTerms*–WSN,RSSI,Kalman filter,Extended kalman filter.**

I. Introduction

Sensor nodes are redistributed in physical world and calculate a few tangible behaviours. There are lots of challenges are present in WSNs. Sensor nodes are very small in size and also they have low processing capabilities. Recent years the scientist get fascinate due to wide variety of WSN applications. Application areas of wireless sensor networks are: monitoring the conditions like temperature, pressure & humidity, Traffic control monitoring, Healthcare monitoring, & also under water acoustics monitoring. WSN have many aspects that can influence the design & performance of networks such as operating system & hardware, localization, quality of services, network security, anchor nodes.[2]

The localization of nodes is being attracted by many of the researchers. The localization holds up abundant actions in WSN like allocation of nodes, directing grid, topology creation, action information & description, & following of items. The WSN operation can't accomplish if consumers are incapable to bring the correct location info of nodes. So how to calculate the geographical position of nodes assigned in a grid is usually noted as localization issue. If the nodes are no more intimated with their tropological locations then there is no use of their information & data. There are two types of nodes are present in the network: 1) Anchor node 2) Unknown node. The anchor nodes are these nodes who know their locations/coordinates. Using their known coordinates, calculating the coordinated of unknown node is the basic concept behind localization. The anchor nodes are usually equipped with the GPS (Global Positioning System) that send the packets with their coordinates so that we can perform the localization of unknown nodes.The GPS is the basic approach for the positioning system but it seems very costly if number of anchor nodes get increased.[3]

There are various technique used to solve the localization problem. The prominence in WSNlocalization is to design profitable, pliable and practical positioning technique. The localization methods are mainly divided into two categories:

1)Range based localization

2)Range free localization

Range based methods uses the distance and angle metrics between the twonodes to determine the localization of unknown nodes. Comparatively range based methods gives the more correct location result but it is costly. Time of arrival (TOA), Angle of Arrival(AOA), Time difference of arrival (TDOA) and received signal strength indication(RSSI) are the range based methods for localization.[3]

The connectivity information between unknown node and anchor node is being used in range free methods. In range free schemes distance –hop algorithm (DV-HOP) is mostly treated as a reference point and most of the results are located according to the deviation in this algorithms. Flows are created when mapping the hops into the distance units because of this DV-HOP doesn't give them enough accuracy.[4]

II. Related Work

There is lots of work is being in process on localization in WSN. Some of these are as follows:

Slavisatomic in "3D target localization in wireless sensor network using RSS and AOA measurements" uses both the distance and angle estimation to localize the 3-D node. The distance and angle measurements is extracted from received signal strength (RSS) and angle of arrival (AOA) information.[5]

Alejsndrocorrea proposed in "Indoor pedestrian tracking system exploiting multiple receivers on the body" that the received signal strength indicator from multiple anchor nodes from an operating wireless sensor network(WSN) and also the multiple receivers are placed around the body. Distance and angle between the users and anchor node is calculated. For more accurate results extended kalman filter is used with constant velocity.[6]

RafinaDestiarti in "Mobile cooperative tracking with RSSI ranging in EKF algorithm for indoor wireless sensor network" proposed that RSSI value for particular mobile node is obtained from nearest three anchor devices continuously. RSSI value is very much fluctuating so that additionally Extended kalman filter is used for error reduction.[7]

S.shukri proposed in "Analysis of RSSI based DFL for human detection in indoor environment using IRIS mote" that the human detection in specified area which is based on device free localization and which is accomplished with the received signal strength indicator.[8]

Shamanthnagaraju in "RSSI based indoor localization with interference avoidance for wireless sensor networks using anchor node with sector antennas" proposes a cost effective localization technique which is based on RSSI with sector antennas. The position technique calculate the target distance for predefined area. Interference avoidance technique is also developed to get correct distance. For developing system 16 micaz target nodes are deployed which is assisted with omnidirectional antennas and also one micaz anchor node is also used.[9]

Amir guidara proposed in "A real time indoor localization platform basedon wireless sensor networks" real time target tracking based on received signal strength indicator(RSSI). Lateration technique is used to calculate the distance between the nodes.[10]

III. PRAPOSED SOLUTION

In this paper indoor localization system is proposed based on WSN. Pure RSSI scheme is used to estimate the distance between the anchor node and unknown node. For more accurate results kalman filter and unscented kalman filters are used.

The architecture which is used in WSN is anchor based. Three sensor nodes are used to create the hardware setup for indoor localization system and for two dimensional space estimation of sensor node a computing machine is used. PC is used as a computing machine to interpret the received data from the sensor network and then calculate the target location. MATLAB is used for the two space plotting.

Signal strength can be calculated at receiver when it receives the packet transferred from transmitter. RSSI is a unit less metric used to estimate the power of the received radio signal that are equipped with an on board transceiver. The RSSI is an analogous indicator and the more the value of the RSSI, the stronger is the signal. The calculated value provided by the module may not be accurately the received power in dBm. Yet, received signal strength indicator (RSSI) is used to give the condition of received power level. This can be simply converted to a received power by applying offset to calibrate to the correct level.[1]

$$RSSI = -(10*n*\log10(d) + A)$$

where

n : path loss exponent (constant & environment dependant)

d : distance at which RSSI is to be found out

A : RSSI at 1 meter distance

RSSI is the unitless metric used to measure the power of the received radio signal,It is represented by one byte integer and can assume any value in range 0 to 255.Nowdays ,most of the trans receiver are equipped with a circuitry that measures RSSI.In this work we use C8051F930 WSN node that are equipped with on board RF-SI4461 trans-receiver.[1]

The Target coordinates using pure RSSI are given as follows

```
A = X1^2 + Y1^2 - d1_est^2;
B = X2^2 + Y2^2 - d2_est^2;
C = X3^2 + Y3^2 - d3_est^2;
X32 = (X3 - X2);
Y32 = (Y3 - Y2);
X21 = (X2 - X1);
Y21 = (Y2 - Y1);
X13 = (X1 - X3);
Y13 = (Y1 - Y3);
X_T = (A*Y32 + B*Y13 + C*Y21) / (2*( X1*Y32 + X2*Y13 + X3*Y21));
% X coordinante of target
Y_T = (A*X32 + B*X13 + C*X21) / (2*( Y1*X32 + Y2*X13 + Y3*X21));
% Y coordinante of target
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Once we get estimated locations using RSSI, Now Next step is to use Kalman Filter or Extended Kalman filter to improve accuracy of estimation process, as RSSI values are generally fluctuating (corruption due to noise).

These filters uses system equation & observation equation.

X = A*X + B*U + [randn; randn; randn; randn]; …………………… system equation ……….(1)

Y = H*X_meas + [randn; randn; randn; randn]; …………………… observation equation…..(2)

Where X = [x; y; x_v; y_v] ………state vector

X_meas =[x_rssi; y_rssi; x_v_calc; y_v_calc]………..observation vector

x & y : initial target coordinates x_v&y_v : initial velocities in x & y directions

x_rssi&y_rssi : target coordinates obtained using RSSI

x_v_calc&y_v_calc : calculated velocities from x_rssi&y_rssi

- We have to use equation 1 & 2 for number of iterations to improve localization & tracking of target
- Find RMSE from estimated locations (using KF / UKF) & actual target locations[1]

1. We will be implementing WSN nodes based on si lab RF chipset
2. Every node will be coin cell operated and will be having RF networking capabilities. On request every WSN node provides its RSSI. We will implement mesh of 8 nodes in first phase
3. A synch node will be connected to PC. And a MATLAB based UI will be used to access this WSN.
4. Using bacons and reference nodes we will map the mesh of 3 nodes to real world GPS coordinates with necessary offsets
5. Once mapping is done and UI is activated, our WSN is ready for getting database of RSSI values relative to unknown node (foreign node)
6. We will move a foreign node with RF source in this WSN. Synch node will generate reading of RSSI every 100ms. All values will be stored in MATLAB database
7. Based on improved results we will compare accuracy of measured position with GPS [1]

IV. RESULTS

As said earlier in this paper three systems are introduced for more accuracy of results which are pure RSSI scheme, kalman filter and extended kalman filter.

Following figures shows the different hardware results for all the technique. Fig1 shows the RSSI curve which is nonlinear with the distance. Fig 2 ,3 and 4 shows the error in estimating the X, Y and XY coordinated respectively. And finally the fig 5 shows the actual target tracking track with anchor nodes and unknown nodes.

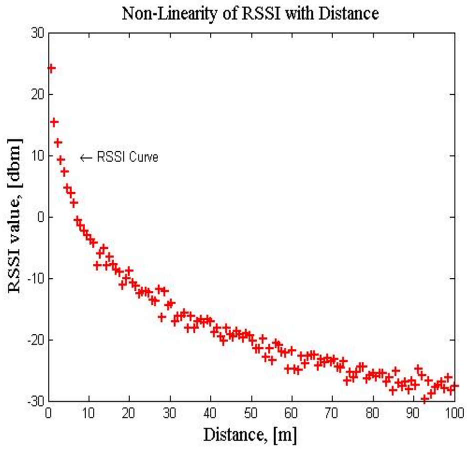

Fig-1

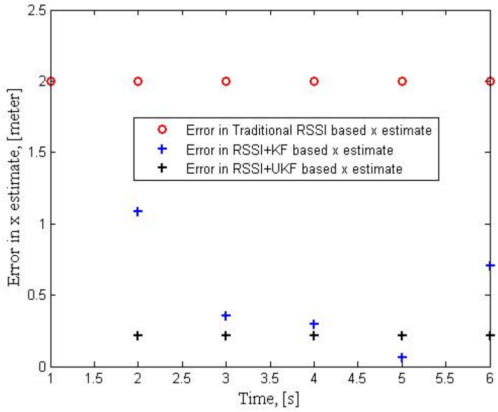

fig-2

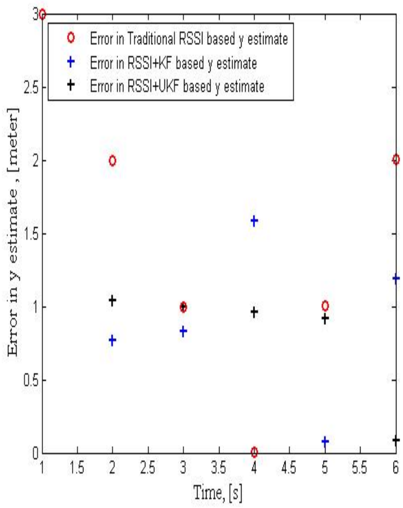

fig-3

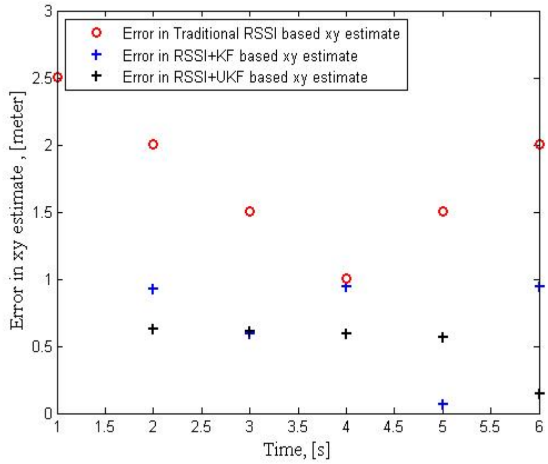

fig-4

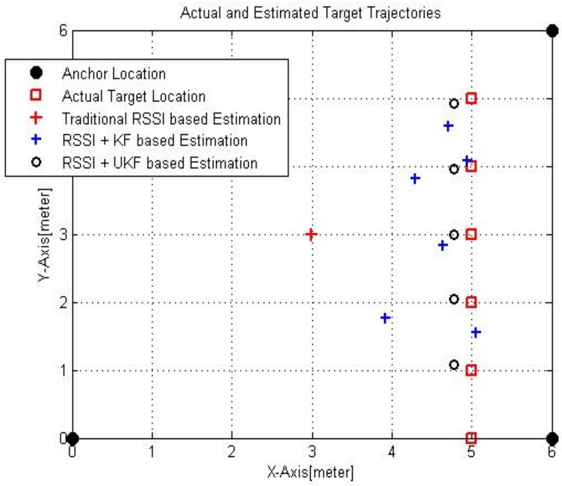

Fig-5

V. CONCLUSION

In this paper by using the RSSI, Kalman and Unscented kalman filter the main objective of increasing the accurancy of target tracking in indoor environment is accomplished. The results shows us that with minimum hardware and complexity the accuracy is being greatly improved

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